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FLOOD INSURANCE STUDY

CITY OF SULLIVAN, MISSOURI

FRANKLIN AND CRAWFORD COUNTIES

DECEMBER 15, 1980

federal emergency management agency
federal insurance administration

COMMUNITY NUMBER - 290136

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY

CITY OF SULLIVAN,
FRANKLIN AND CRAWFORD COUNTIES, MISSOURI

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Sullivan, Franklin and Crawford Counties, Missouri, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Sullivan to the regular program of flood insurance by the Federal Insurance Administration (FIA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.1 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Booker Associates, Inc. for the Federal Insurance Administration, under Contract No. H-4370. This study was completed in November 1979.

1.3 Coordination

Streams requiring detailed study were identified at a meeting attended by representatives of the Study Contractor, the FIA, and the City of Sullivan in March 1978.

On July 23, 1980, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor and the FIA, and community officials.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Sullivan, Franklin and Crawford Counties, Missouri. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through November 1984.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by the FIA and the City of Sullivan.

Floods caused by Winsel Creek from the northern corporate limits to Elmont Road were studied by detailed methods. Winsel Creek upstream of Elmont Road and several tributaries to Winsel Creek (Airport Tributary, Golf Course Tributary, Southwestern Tributary, Winsel Creek Tributary, and Southeastern Tributary), North Tributary of Stater Creek, and Pump Hollow Creek were studied by approximate methods. The Northern Tributary of Stater Creek, Southeastern Tributary of Winsel Creek about 4,800 feet upstream of the northern corporate limit, and Pump Hollow Creek about 2,150 feet upstream of the southern corporate limit, were determined to have approximate boundaries permanently less than 100 feet wide. These areas were determined to be areas of minimal flood hazard.

2.2 Community Description

The City of Sullivan, Missouri, is located in the east-central portion of the state on the Franklin/Crawford county line. It is 70 miles southwest of St. Louis. The community, which encompasses an area of approximately 3.7 square miles, had a population of 5,111 in 1970 (Reference 1). Sullivan is bordered on the north by unincorporated areas of Franklin County, on the northeast by the Village of Oak Grove, and on the south by unincorporated areas of Crawford County. The community's major thoroughfares are Interstate Highway 44, which runs east and west, and State Highway 185, which runs north and south. The St. Louis-San Francisco Railway runs through Sullivan in a northeast-southwest direction.

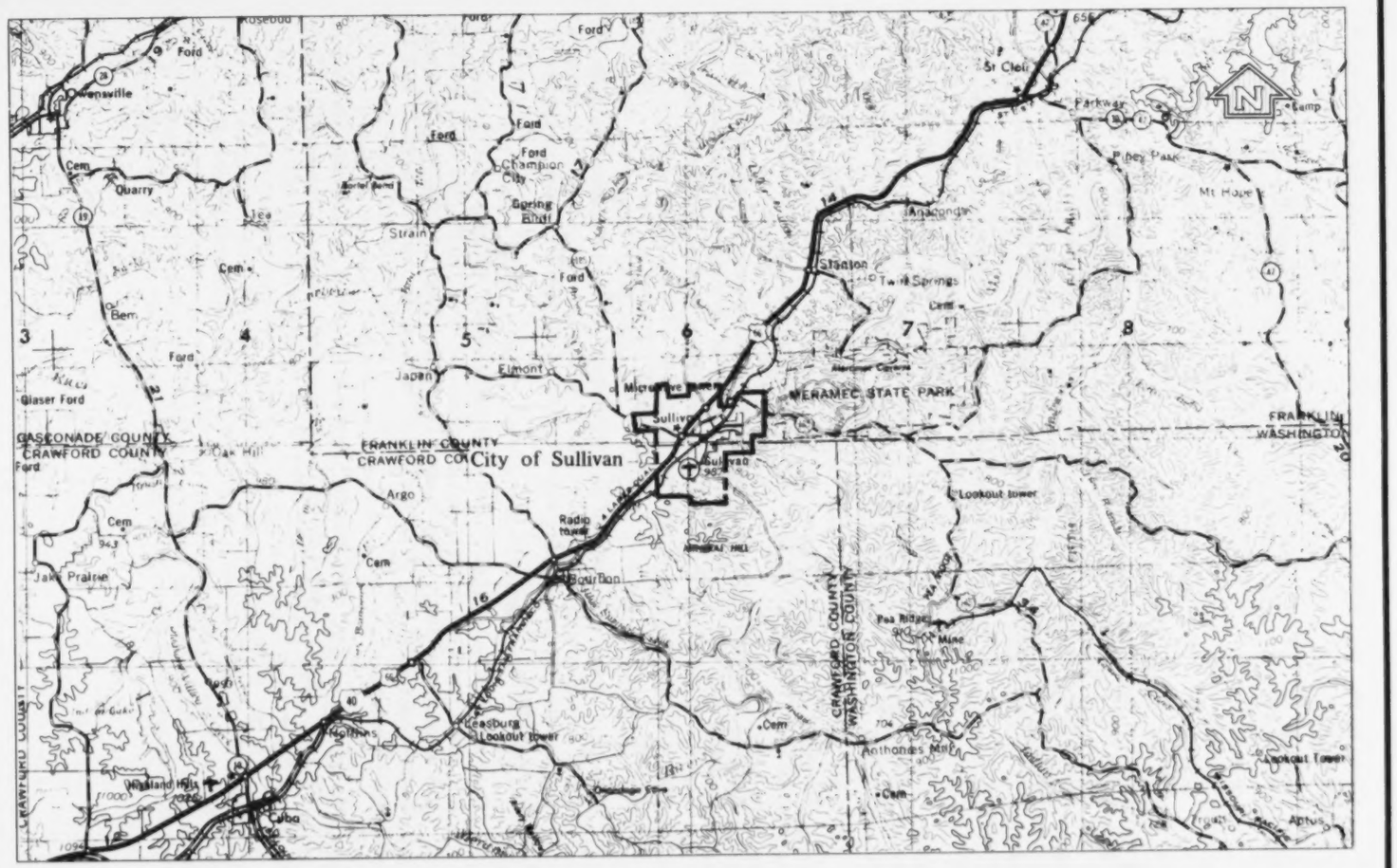


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF SULLIVAN, MO
(FRANKLIN AND CRAWFORD COS.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

Climate for the area is typified by the following seasonal temperature variations:

Season	Average High Degrees Fahrenheit (F.)	Average Low
Winter	46	25
Spring	67	44
Summer	86	64
Fall	69	47

Temperature extremes have ranged from -20 degrees F. to 110 degrees F. Annual precipitation averages approximately 37 inches, distributed fairly evenly throughout the year. Monthly precipitation will vary from approximately 1.5 inches per month in December, January, and February, to 4.5 inches per month in May, June, and September (Reference 2).

The topography of the community is characterized by gently to moderately rolling terrain, with steeper hills and hollows in the southeast portions of the city toward the nearby Meramec River. Runoff from the northwest half of the city drains into Winsel Creek, while the southeast portions of the city are drained by Pump Hollow Creek and other tributaries into Slater Creek.

Soils in Sullivan are of the Union-Goss-Gasconade-Peridge Association. They are deep and shallow, nearly level to very steep, moderately well-drained to excessively drained, loamy and clayey upland soils (Reference 3).

Union is a moderately well-drained soil formed in loess and cherty limestone residuum and has a fragipan. Most of it is on ridgetops and upper side slopes. It has a silt loam surface soil grading to a slowly permeable silty clay subsoil overlying a massive fragipan. Slopes range from 3 to 20 percent.

Goss is a deep, well-drained soil formed in cherty limestone residuum on steep upland slopes. It has a cherty silt loam surface soil overlying a moderately permeable, very cherty, silty clay subsoil. Slopes range from 2 to 45 percent.

Gasconade is a shallow, somewhat excessively drained soil formed in limestone residuum on steep upland slopes. It has a flaggy clay loam surface soil overlying a flaggy, clay subsoil that has moderately slow permeability. Slopes range from 2 to 50 percent with the most common between 20 and 35 percent.

Peridge is a deep, well-drained upland soil formed in loess and limestone residuum. Karst topography is common in some areas. It has a silt loam

surface soil overlaying a moderately permeable silt loam subsoil. Slopes range from 0 to 20 percent.

Commercial and industrial development is concentrated mostly along Interstate Highway 44 and Main Street. Residential development is found throughout the remainder of the community. Land use in the detailed study flood plain is mostly farming or undeveloped.

2.3 Principal Flood Problems

Winsel Creek is the major source of flooding within the community. The flood plains are primarily farmland or undeveloped, and, therefore, flood problems are limited to the inundation of fields and a few crossroads.

The tributaries of Winsel Creek extend into the more urbanized areas of the city and cause minor flooding, generally due to restricted culvert openings. The areas most commonly affected are the intersection of Elmont Road and Springfield Road in the southern end of the city, and at the ends of Grace Avenue and Meramec Drive in the north.

Minor flooding also occurs between Clark and Church Streets, northwest of the railroad track in the downtown area. This flooding often extends down Euclid Avenue toward the Elmont Road/Springfield Road area previously mentioned.

Flooding in these areas and along Winsel Creek is generally caused by flash flooding from localized storms. Flash flooding results from the intense thunderstorm activity associated with the midwest where large masses of cold and warm air collide. This type of flooding is characterized by a rapid rise in stream levels with durations usually restricted to several hours.

The most recent occurrences of this type occurred on August 26, 1975, and August 10 and 22, 1977. Rainfall amounts for these dates were 3.71, 3.70, and 4.91 inches, respectively (Reference 4).

2.4 Flood Protection Measures

There are no flood protection measures which can prevent flooding from the 10-year or longer recurrence interval.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater

than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for the flooding source studied in detail affecting the community.

Flood-discharge data for the 10-, 50-, and 100-year frequencies for the stream studied by detailed methods were determined by the empirical relationships presented in the U.S. Geological Survey (USGS), Water Resources Division, Open-File Report by E. E. Gann (Reference 5). These relationships consisted of USGS regional equations determined for Missouri with parameters of drainage area and slope.

Discharge for the 500-year flood was determined by straight line extrapolation of a log-probability graph of flood discharges computed for frequencies up to 100 years.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of the flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
WINSEL CREEK					
Downstream corporate limits	3.98	1,880	3,020	3,630	4,814
County Highway AF	3.04	1,690	2,720	3,240	4,120
7,200 feet upstream of County Highway AF	2.12	1,650	2,580	3,050	3,700
At Elmont Road	0.62	500	810	940	1,190

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along the flooding source studied in detail.

Valley and channel cross sections were obtained from aerial photogrammetry at selected locations to determine hydraulic characteristics. Topographic maps at a scale of 1:4800 were prepared with four-foot contours and were used to supplement cross sections (Reference 6). All bridges and culverts were field checked to obtain elevation data and structural geometry. For the portion of Winsel Creek under Interstate Highway 44, plans were obtained from the Jefferson City office of the Missouri State Highway Department (Reference 7).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Channel roughness factors (Manning's "n"), used in the hydraulic computations, were chosen by engineering judgment and based on field observations of the streams and flood plain areas. Roughness values for the main channel of Winsel Creek range from 0.035 to 0.075 with flood plain roughness values ranging from 0.035 to 0.085 for all floods.

Starting water-surface elevations for Winsel Creek were obtained from the Franklin County, Missouri, Flood Insurance Study (Reference 8). Water-surface elevations of floods of the selected recurrence intervals were computed through use of the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 9). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

For the approximate study area, the flood boundaries were delineated on USGS topographic maps (Reference 10) on the basis of field reconnaissance using normal depth analysis with consideration given to the existing storm drainage facilities.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using topographic maps at a scale of 1:4800, with a contour interval of four feet (Reference 6).

For the streams studied by approximate methods, the boundary of the 100-year flood was developed using USGS topographic maps at a scale of 1:24000, with a contour interval of 10 feet (Reference 10) on the basis of field reconnaissance using normal depth analysis with consideration given to the existing storm drainage facilities.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2). Portions of the Winsel Creek floodway are located outside of the corporate limits of the City of Sullivan.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FEET)
WINSEL CREEK							
A	4660	369[2]	177	2.0	904.7	903.8	0.9
B	5392	153[3]	822	4.4	906.0	905.1	0.9
C	7066	90	683	4.7	913.7	912.8	0.9
D	8467	225	1000	3.2	917.9	916.9	1.0
E	9784	210	1049	3.1	922.0	921.1	0.9
F	11,777	313	1443	2.2	926.6	925.7	0.9
G	12,897	345	1264	2.4	930.8	929.8	1.0
H	15,252	75	173	5.4	938.9	938.1	0.8

[1]FEET ABOVE CEMETERY ROAD
[2]THIS WIDTH IS BEYOND CORPORATE LIMITS
[3]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF SULLIVAN, MO
(FRANKLIN AND CRAWFORD COS.)

FLOODWAY DATA

WINSEL CREEK

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

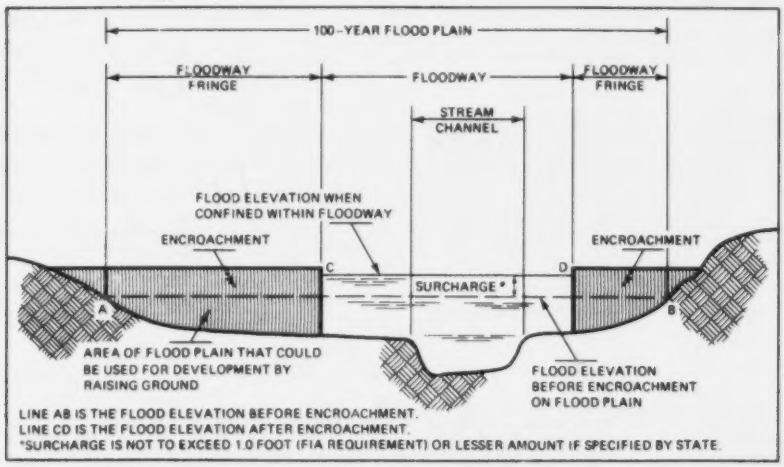

100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT.
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT.
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FIGURE 2 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the City of Sullivan.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Sullivan are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the City of Sullivan was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zones A2, A4:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Sullivan is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

A Flood Insurance Study for the unincorporated areas of Franklin County, Missouri, will be in agreement with this study (Reference 8). There are no other existing studies in this area.

A Flood Hazard Boundary Map has been published by the Federal Insurance Administration (Reference 11). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
WINSEL CREEK							
REACH 1	0002	–1.8	–0.5	0.8	020	A4	VARIES–SEE MAP
REACH 2	0002	–1.0	–0.3	0.4	010	A2	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF SULLIVAN, MO
(FRANKLIN AND CRAWFORD COS.)

FLOOD INSURANCE ZONE DATA

WINSEL CREEK

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the Insurance and Mitigation Division, Federal Emergency Management Agency, 911 Walnut Street, Kansas City, Missouri 64106.

8.0 REFERENCES AND BIBLIOGRAPHY

1. Missouri Municipal League, Directory, 1978-79, Missouri Municipal Officials, July 1978.

2. Missouri Department of Natural Resources, Outdoor Recreation Plan, September 1976.

3. U.S. Department of Agriculture, Soil Conservation Service, Missouri General Soil Map and Soil Association Descriptions, 1972.

4. Unpublished Records of the Missouri Conservation Department, Meramec Fire Protection District, Sullivan, Missouri (Station Number 234501).

5. U.S. Geological Survey, Water Resources Division, Generalized Flood-Frequency Estimates for Urban Areas in Missouri, Open-File Report, E. E. Gann, Rolla, Missouri, 1971.

6. Surdex, Inc., Aerial Topographic Maps, Scale 1:4800, Contour Interval four feet: Winsel Creek, Franklin County, Missouri, December 1978.

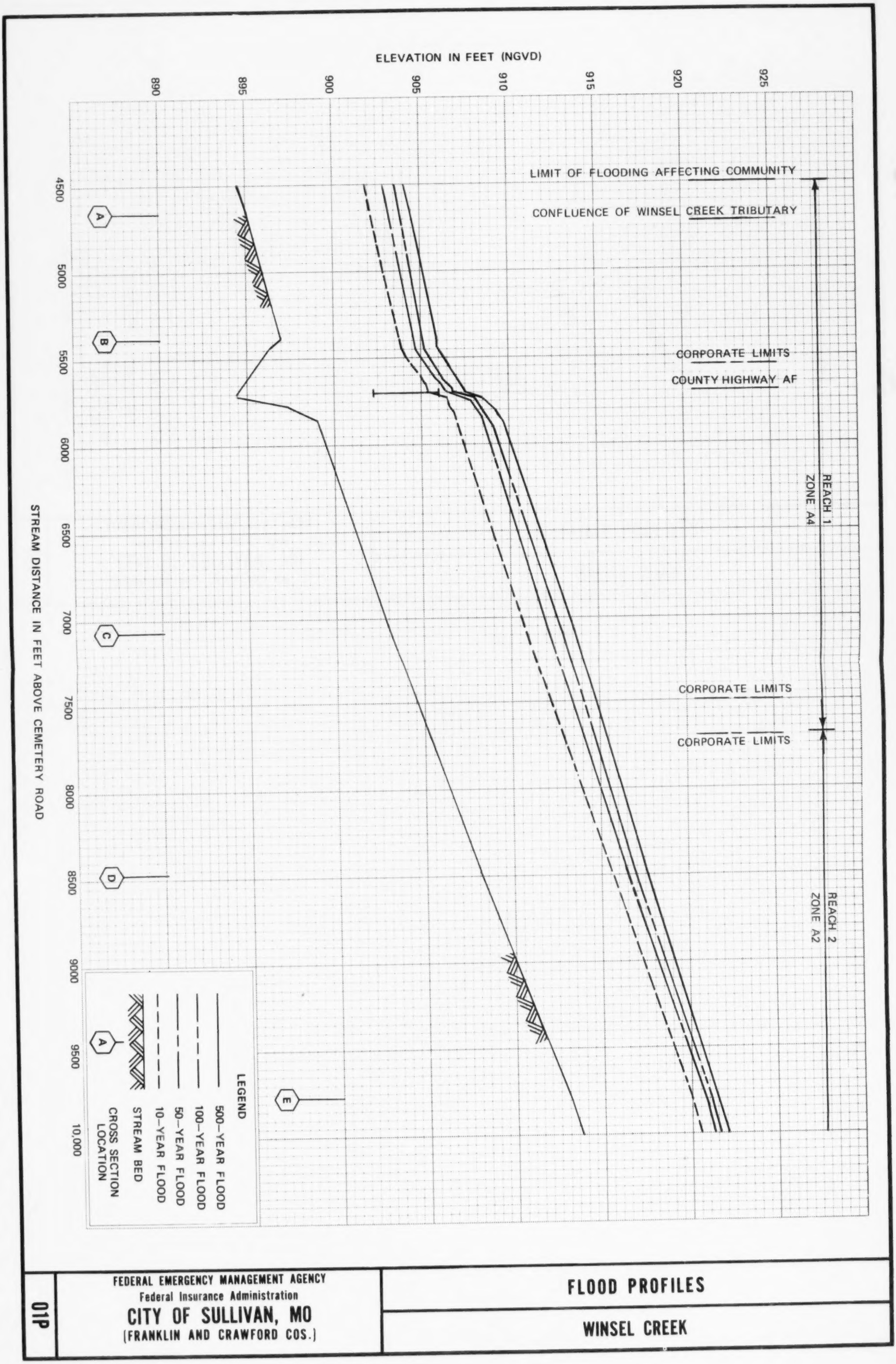
7. Missouri State Highway Department, Project Nos. I-44-3(21), FI-258(3), FI-258(6), Franklin County, Missouri.

8. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Unincorporated Areas of Franklin County, Missouri, (in progress).

9. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2, Step-Backwater Computer Program, Davis, California, September 1969, (updated) August 1976.

10. U.S. Geological Survey, 7.5 Minute Series Topographic Quadrangle Map, Scale 1:24000, Contour Interval 10 feet: Sullivan, Missouri, 1959.

11. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Sullivan, Missouri, November 1975.



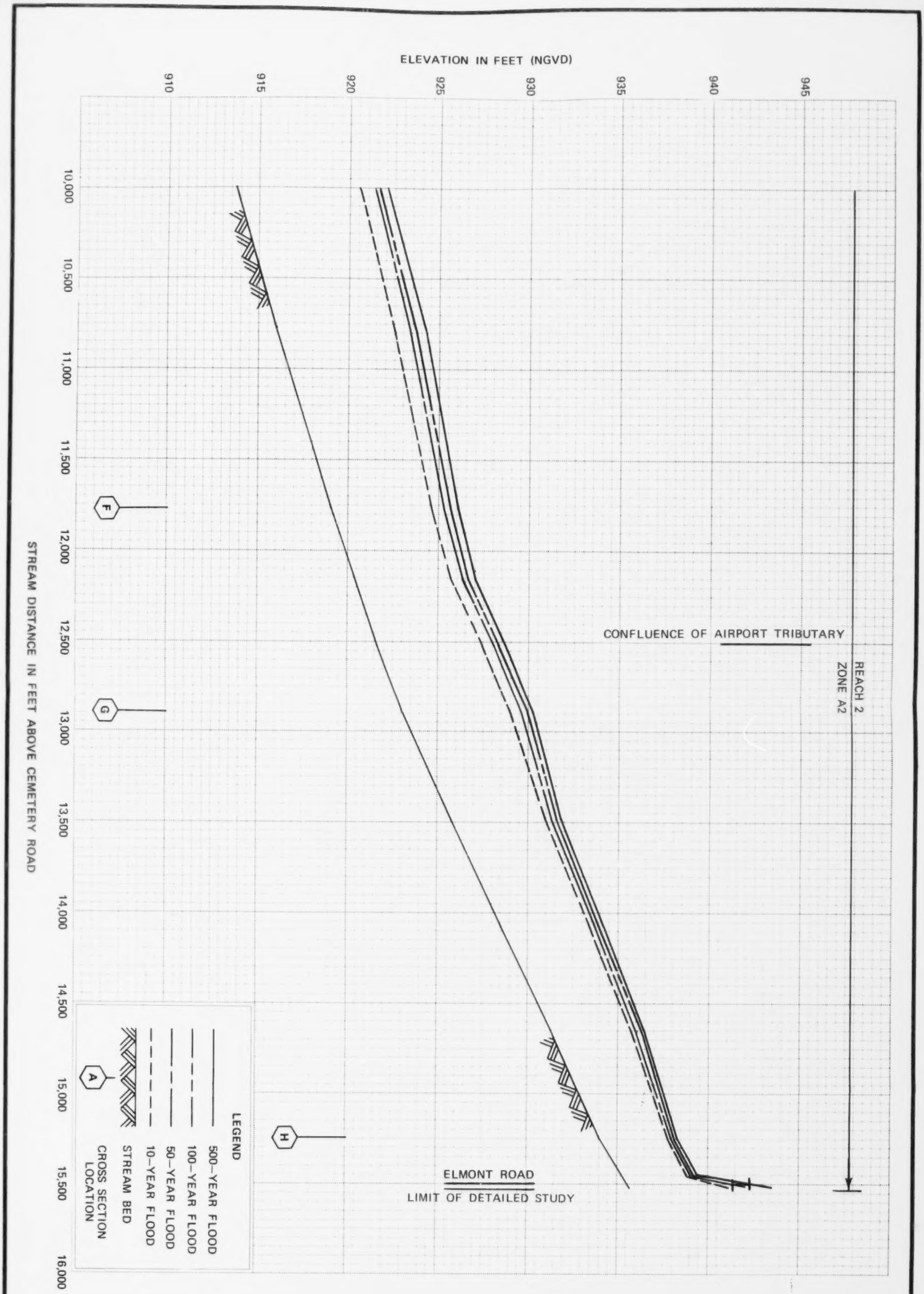
01P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF SULLIVAN, MO
(FRANKLIN AND CRAWFORD COS.)

FLOOD PROFILES

WINSEL CREEK



02P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF SULLIVAN, MO
(FRANKLIN AND CRAWFORD COS.)

FLOOD PROFILES

WINSEL CREEK